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AN EVALUATION OF RESTOCKING WITH PEN-REARED BOBWHITE¹

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To determine the value of restocking with pen-reared bobwhite, a survey of the literature and the activities of 17 important bobwhite States was made in 1948. It has become clear, after much trial and error in a number of localities, that the release of propagated pen-raised birds does not necessarily or always accomplish the desired population increases. A growing number of thoughtful administrators and sportsmen have raised questions concerning the expense of propagating bobwhite and the results obtained from game-farm birds. It is the purpose of this paper to present available information that may help to answer these questions.

The data presented here were compiled as part of long-range bobwhite research initiated by the Oklahoma Cooperative Wildlife Research Unit at the request of the Oklahoma Game and Fish Department under the direction of Director Kelly E. DeBusk. Walter

P. Taylor, Leader of the Unit, and Fred M. Baumgartner, Department of Zoology, Oklahoma Agricultural and Mechanical College, have given time and supervision to the investigation and have assisted in the preparation of the present paper.

PREVIOUS INVESTIGATIONS

A few carefully conducted experiments have been made in Oklahoma, Missouri, Virginia, and Illinois to determine the efficacy of restocking. Taylor (1948) discusses artificial propagation in the southern States and points out that it apparently is impossible to produce sufficient numbers of bobwhite on game farms to supplement appreciably the natural production of native populations. The results show that up to this date, at least, releasing game-farm bobwhite is costly, and State game departments cannot justify the practice on an economic basis alone.

Clark (1942), reporting on a survey of restocking in 25 States, pointed out that in 1941 only 333,709 bobwhite were produced by artificial means in the entire United States at a cost of \$285,615.00, or 22 per cent of the money spent on all kinds of game restocking.

¹ Contribution from the Oklahoma Wildlife Research Unit, the Oklahoma Game and Fish Department, the Oklahoma Agricultural and Mechanical College, the Wildlife Management Institute, and the Fish and Wildlife Service, U. S. Department of the Interior, cooperating.

indicate an extremely high pre-hunting-season mortality. Apparently the majority of artificially reared birds succumb from lack of ability to adapt themselves to changes in food, temperature, moisture, the presence of natural enemies, or other conditions.

Duck and Fletcher (1944) conclude that low populations due to causes not regular in occurrence may be aided in recovery by releases of hatchery stock under good habitat conditions provided the areas are too large for restocking through natural spring shifting of wild birds. Causes of irregular low populations may be overshooting, severe local hailstorms, winter storms, droughts, and floods. Overshooting must be controlled, and low populations from this cause cannot be economically aided by release of hatchery stock year after year. It simply costs too much. Release of game-farm bobwhite is thought to be justified also as a means of encouraging habitat improvements by individual landowners. Duck and Fletcher point out that on 225 refuges in western Oklahoma 87 per cent of the refuge acreage and 85 per cent of the released stock in 1940 could be classified as unjustified. They believe that the percentage of unjustified releases would be increased with the inclusion of eastern Oklahoma. According to these authors adverse factors such as those mentioned operate more effectively in the western part than in the eastern part of the State.

ILLINOIS

One of the best-known studies of the value of artificial restocking is that of the Western Cartridge Company at East Alton, Illinois (Hart and Mitchell 1941). Investigations were made over a five-year period on a 1,200-acre tract

of land where hunting was permitted. Spring releases apparently were far less effective than fall releases. From 108 banded bobwhite released in the spring of 1940 only one was recovered. During the previous year no bands were recovered from spring releases. Some success in restocking was indicated by recoveries of autumn releases. In 1940, bands from 57 (18 per cent) out of 319 birds were returned. This comparatively high percentage of return seems encouraging, although the cost per bird banded was rather high (\$3.00 to \$4.00). While it may be possible for private individuals or sportsmen's clubs to restock at these costs, State game departments would find it difficult, at these rates, to provide a sufficient number of game-farm birds to supplement materially the natural production and increase the annual harvest. Thus, if the estimated 2,000,000 birds killed in one year by hunters in Oklahoma could be produced in hatcheries at these favorable Alton, Illinois rates they would cost \$6,000,000 to \$8,000,000!

Ralph E. Yeatter (Anonymous 1947), Game Specialist of the Illinois Natural History Survey, states that it would be necessary to expand greatly the already large number of propagated bobwhite released annually in the State to add even one bird per year to each covey reared in the wild. He also states that it is impossible on economic grounds for any State conservation department to propagate quail on the tremendous scale that would be necessary to insure good hunting each year.

MISSOURI

A carefully controlled three-year experiment by Bennett (1944) is one of the most noteworthy contributions to

our knowledge of bobwhite restocking. Two areas, each slightly over 2,000 acres in extent, were selected for the study; one was heavily stocked with pen-reared bobwhite each spring (1942-1944) and the other served as a control area. A total of 366 healthy, banded birds were released during the three-year period. Each spring before the covey breakup and each fall before the hunting season both areas were carefully censused with dogs by staff members and students of the University of Missouri and many interested sportsmen from Columbia. Results of the investigation showed: (1) The unstocked area carried a higher population of birds, (2) the population on the stocked area was actually smaller each year in relation to the unstocked area, (3) the pen-reared quail did not supplement the natural reproduction, (4) each winter the population of the stocked area decreased to the usual carrying capacity for wild birds, and (5) no bands were recovered from the 366 banded birds although about 100 birds were killed each season on the stocked area. The study indicated clearly that if conditions are right, the birds will be there regardless of restocking. If additional carrying capacity does not exist, additional birds are wasted.

The Conservation Federation of Missouri (Anonymous 1947) recently made a survey of 15 leading quail-hunting States. Ten of these (11 including Missouri), Arkansas, Mississippi, Florida, Texas, Oklahoma, Alabama, Pennsylvania, North Carolina, Georgia, and Illinois, reported that releasing pen-reared quail did not contribute to hunting success. West Virginia reported that restocking contributes slightly,

Virginia termed the effects "doubtful," and Tennessee reported that sufficient information for definite conclusions was not available for the state. Only two, South Carolina and Kentucky, replied that they considered restocking an effective measure. However, South Carolina does not release pen-raised birds, and Kentucky believes artificial replenishment helps principally in public relations. The Missouri survey prevented political pressure groups from forcing the State Conservation Commission to establish an expensive program of propagation.

VIRGINIA

The results of bobwhite restocking experiments (Phelps 1948), conducted by the Virginia Commission of Game and Inland Fisheries as a part of its Pittman-Robertson program, indicate that liberations of pen-reared bobwhite are not worthwhile. Several units, each consisting of two areas, were chosen for the study. All native bobwhite were removed in the fall from one area ("A") by shooting in the fall, and the area was stocked with banded pen-reared birds in the same number and sex ratio as those removed. One year later the birds were again removed by shooting to determine survival of banded birds and production of young. Area "B" within the unit was treated in a similar manner, except that the wild bobwhite were removed by shooting in the spring.

Unit I, area "A," consisting of 165 acres, was restocked with 20 banded bobwhite in December 1941. All birds were removed by shooting in November 1942; of the 30 bobwhite removed, only one was banded. Area "B" was restocked with 20 banded pen-raised birds in April 1942. In November

1942 no bands were recovered from the 38 quail removed from the area. In Unit II, area "A" was not treated because of loss of personnel to military service. Area "B" was restocked with 24 banded bobwhite in April 1942. None of the 19 birds removed in October 1942 was banded. A third unit was established to test the possibility of establishment of bobwhite on an area where none existed. In the spring of 1942, an area which had no quail population was stocked with 20 banded pen-reared birds. No bands were recovered from the 6 birds killed in October and November 1942. Repeated hunting for several weeks failed to reveal additional birds. Although the data are meager and the bobwhite could not be completely controlled from "drifting" in and out of the areas, the studies indicate that the carrying capacity of the land is one of the principal factors limiting the quail population.

Handley (1935) reports that of 237 captivity-reared birds released in the summer and fall of 1931, 26 per cent were retrapped (61 birds) or otherwise accounted for (3 killed by predators) after a lapse of 5-9 months. One additional bird was shot in November 1932 and 5 more were recovered by trapping in the spring of 1933, bringing the total return to 68 birds or about 29 per cent. In comparison, 245 young and adult wild-trapped bobwhite banded and released in October, November, and December 1925, showed a 35-per-cent return from shooting or retrapping during the ensuing winter. Seemingly this indicates that captivity-reared bobwhite are not handicapped in comparison to wild birds; but Handley later states that habitats will not sup-

port and hold more than appropriate numbers regardless of how many additional birds may be dumped into them.

TEXAS

In 1942, the Texas Game, Fish and Oyster Commission made an extensive survey of bobwhite restocking (Anonymous 1942, 1945) and concluded that artificial propagation could not be regarded as a sound management practice. As a result of this and other surveys, Texas has never established state bobwhite hatcheries. The administrators have felt that more bobwhite could be produced for the hunters' guns if money were spent rather for education and habitat improvements than for artificial propagation.

As an experiment, the Texas Cooperative Wildlife Research Unit purchased 52 pen-raised bobwhite from a Florida breeder and released them on excellent East Texas range in March 1936. They evidently died or moved away, for none was retaken in three years of extensive trapping. Apparently unaccustomed predation and starvation through failure to recognize native weed seeds as acceptable items of food accounted for most of the deaths.

Recently, Lehmann (1948) has been successful in transplanting "wild-trapped" bobwhite from areas of abundance to depleted areas on the King Ranch in South Texas. Birds were transplanted only to situations where populations had been decimated and natural barriers inhibited ingress. One area of approximately 20 sections that contained only two coveys in the spring of 1946 had not supported a shootable population since a hurricane in 1916. Eighty birds were released in 1946 and an additional 120 in 1947. The present popula-

tion is about 50 coveys. Under these special conditions restocking appears to bring results.

KENTUCKY

Phelps (1948) reports that a carefully supervised experiment in Kentucky showed that only 28 per cent of 360 bobwhite stocked in the fall on several areas could be located 45 to 60 days later. Only 8 per cent survived to April of the following year. Census data revealed that more birds per unit area were present on the unstocked check areas than on the restocked areas. Experiments with older bobwhite released in the spring showed that the survival success was even less than with fall-released birds; few birds could be found within several weeks after liberation.

PENNSYLVANIA

The Pennsylvania Game Commission expressed its view recently (Anonymous 1947) that releasing pen-reared bobwhite to increase populations has been unsatisfactory and that unless better results were produced, the practice of releasing such birds would be discontinued. Gerstell (1938) reported only 76 bands (0.61 per cent) returned from 12,420 bobwhite released in Pennsylvania. No estimate was made on the number of bands taken by hunters but not turned in. Restocking, according to Gerstell (1937), has probably been the least effective of the Commission's quail-management practices.

A study of propagated bobwhite and wild bobwhite under laboratory conditions (Nestler and Langenbach 1946) revealed that the outstanding difference between the wild birds and pen-reared stock was in the degree of wariness. Pen-reared birds learned quickly how

to forage for wild foodstuffs. Indications from this study are that the propagated bobwhite may find difficulty in coping with natural enemies.

INDIANA

Barnes (1947) reports that a Pittman-Robertson study of 6,098 bobwhite released over a period of 3.5 years showed about 3 per cent return, or less than 1 per cent of the total hunters' kill for bobwhite in 1945. Only 2 per cent of the band returns were received after the first season, indicating a short average life span as with wild bobwhite. He states that artificial propagation is not the answer to Indiana's game-bird problem.

In a recent article, Reeves (1948) says that where food and cover conditions are so poor that wild birds cannot maintain themselves it appears foolish to expect pen-reared birds to overcome these handicaps. Yet sportsmen believe that the release of birds on areas devoid of good cover overcomes the deficiency of the site.

LOUISIANA

Analyses of returns from artificially raised bobwhite in Louisiana (Campbell *et al.* 1943) show that moderate survival was followed by low hunter success. Of birds liberated in pairs in the spring, 61 per cent raised broods averaging 13; about 30 per cent were killed by predators and accidents. Only about 3 per cent of the spring-released birds and their progeny were killed during the hunting season. Of birds liberated in groups of 10-20 in the fall, 19 out of 48 continued as covey units while 27 mingled with wild birds. All remained near the point of release.

During the hunting season 7 per cent of the fall-released birds were killed.

FLORIDA

A limited study of the comparative fall and winter survival of wild and pen-reared bobwhite was made by Frye (1942). His data indicate an approximate equality of survival between the two types of birds. Intimate contact with the birds on a 2,180-acre study area enabled Frye to record detailed histories of the coveys. For comparison of survival success, 160 pen-reared bobwhite were released in 22 check groups each of which consisted of one-half wild birds and one-half hatchery birds, all banded. At the time of final trapping (January 23-February 7), 45 wild and 18 pen-reared birds were surviving out of 83 birds of each category released between August 24 and October 25. It is suggested that releasing pen-reared birds with a few wild-trapped birds as "leaders" may be of practical application in broad-scale restocking.

Game administrators in Florida recently stated (Anonymous 1947) that pen-raised birds had been used in the past but that the percentage of survival had not been high enough to warrant expenditures for restocking.

NEW MEXICO

Ligon (1948) strongly advocates artificial aid to upland game birds in the southwest. He states that artificial propagation is mandatory where the birds must exist in scant habitats and are subject to severe winters, prolonged droughts, and heavy overgrazing. It should be emphasized that the ecological conditions found in New Mexico do not apply to the more favorable environments of the bobwhite

range farther east. By the use of "adjusting units" Ligon has demonstrated that releasing pen-reared quail may be successful. More than 500 quail were liberated in 1915 and checked in 1947. Better than 90 per cent survival was obtained of pen-raised scaled, Gambel and bobwhite quails. The average numbers of young per pair raised to maturity were: Scaled quail, 8; Gambel quail, 6; and bobwhite, 10. A comparable check of 90 wild resident scaled quail showed an average of only 3 young per pair raised to maturity. The population density on the control area (about 500 acres) was more than one bird per acre at the end of the second year. Only a few scaled quail and no bobwhite or Gambel quail were present before the experiment. It is significant that releases were made where practically no quail existed; liberations in Oklahoma and other States are usually made where good populations already exist. The New Mexico Game and Fish Commission has recently embarked on an adjustment-unit program for upland game birds. Major objectives are: (1) Proper orientation of propagated stock, (2) care of resident birds in times of need, (3) insurance of survival of transplanted wild stock, and (4) expansion of ranges. It will be interesting to observe the progress in application of this new wildlife technique.

GEORGIA

In his well-known monograph on the bobwhite, Stoddard (1931) pointed out that investigations are greatly needed to determine the percentages of pen-reared bobwhite, released by different methods, that become adjusted to their environment and survive the many dangers confronting them afield. Later

(Stoddard 1936), he emphasized that environmental improvement is superior to and more economical than restocking.

MISSISSIPPI

The Mississippi Game and Fish Commission has become one of the strongest opponents of restocking with upland game birds. It has been emphatically stated (Anonymous 1946) that the money of Mississippi hunters should not be wasted on restocking and that the problem is probably mostly one of food and cover for bobwhite.

BOBWHITE STATE GAME FARM ACTIVITIES AND RESTOCKING

A current questionnaire-survey of 17 bobwhite States is summarized in Table 1. Six of the States (Alabama, Arkansas, Florida, Missouri, North Carolina, and South Carolina) have completely abandoned their bobwhite farms. Mississippi and Texas have no game farms. Indiana, Pennsylvania, and Virginia have decreased their game-farm bobwhite production. Georgia distributes bobwhite eggs to 4-H and FFA Clubs as a public-relations measure to create interest among boys and girls. Iowa and Louisiana maintain their production at 5,000 to 8,000 bobwhite per year. West Virginia increased production from 6,000 in 1917 to 9,000 (estimated) in 1948. Only Oklahoma and Kentucky reported a considerable increase in bobwhite production and at least a slight increase in the annual harvest, based on the return of bands from the pen-raised birds. Oklahoma produced about 60,000 and Kentucky 36,400 in 1948.

The survey shows that most States are in agreement that artificial restock-

ing is not effective in augmenting either the total population or the annual harvest of bobwhite. It shows, furthermore, that with two significant exceptions (Oklahoma and Kentucky) bobwhite game farms are being abandoned and production decreased. The national trend is definitely away from restocking with pen-reared bobwhite as a means of supplying greater numbers of bobwhite for the hunter.

WHERE AND WHEN TO RESTOCK

According to Studholme (1948), game stocking is justified: (1) On areas known to meet the species requirements, but where the species has been killed out, (2) on formerly good range where the habitat was eliminated and has since developed into suitable environment, (3) on areas that lack a satisfactory native species yet provide proper habitat for a desirable non-native, and (4) on areas where the sex ratio has been so distorted that the species cannot properly reproduce. If these criteria are followed, restocking from state game farms will take its place as a minor management practice. Almost invariably pen-reared bobwhite are now released on areas where native populations already exist. Without increasing the carrying capacity of a particular area through definite habitat improvement, increases in the quail population cannot be expected. Hart and Mitchell (1947) repeatedly point out that before pen-raised birds are liberated the habitat must be improved to increase the carrying capacity of the land.

The question still remains whether birds should be liberated even on improved areas where there is a source of supply of native wild birds. The work of Murray (1948) on habitat improve-

TABLE 1. BOBWHITE GAME FARM ACTIVITIES AND RE STOCKING IN 17 STATES 1948

State	Game Farm Status	Cost/Bird Released	Comments
Alabama	Abandoned 5 years ago	\$3.00	Restocking did not increase the annual harvest
Arkansas	Abandoned	—	To increase harvest, bobwhite should be released during open season
Florida	Abandoned	\$1.50-2.50	High mortality in pen-raised quail and high cost made restocking worthless
Georgia	Eggs distributed to 4-H and FFA Clubs	—	Restocking was attempted for 18 years with no success. Expenditure for distribution of eggs is justified by the interest created among boys and girls
Indiana	Production decreased considerably	—	Artificial restocking is not the answer to Indiana's game-bird problems
Iowa	Production maintained at 6,000-8,000 per year	\$0.68	The state has no positive evidence that bobwhite have increased because of restocking
Kentucky	Production increased considerably	\$0.78	That annual harvest has been increased at least slightly is corroborated by the return of bands from the pen-raised birds
Louisiana	Production maintained at 5,000-6,000 per year	\$2.00-2.50	All bobwhite are carried through winter for spring distribution. No positive evidence to indicate an increase in annual harvest, but it is believed that pen-reared bobwhite do increase the population
Mississippi	No bobwhite game farm	—	Considering the large annual harvest of quail by hunters, we do not believe that restocking with quail is necessary. There are no places in the state where there is not adequate seed stock of quail
Missouri	Abandoned	\$2.00	All bobwhite farms were abandoned in the spring of 1938. Research indicates failure of restocking to augment the natural harvest. The cost per bird survived in the spring of 1938 was \$32.00
North Carolina	Abandoned	—	The last year of game-farm operation was 1912. The release of game-farm-reared bobwhite did not increase the annual harvest
Oklahoma	Production increased to about 60,000 in 1948	—	Some game administrators and sportsmen feel that restocking increases both the population and annual harvest. Bobwhite are reared the last 4 weeks by 85 cooperating sportsmen's clubs
Pennsylvania	Increased production up to 1948; decreased this year	—	Populations established themselves and became fairly abundant in certain sections where bobwhite were extinct in 1936; this could have been accomplished only by restocking
South Carolina	Abandoned	—	Our native supply is sufficient to take care of our needs in most parts of the State
Texas	No game farms	—	On the basis of a survey of bobwhite restocking in other States which indicated the futility of the method, Texas never established a game farm
Virginia	Production decreased	Estimated at \$3.00	Research in Virginia indicates that restocking does not increase the annual harvest
West Virginia	Production slightly increased	\$3.00 for spring-released birds	Production increased from 6,000 in 1947 to 9,000 (estimated) in 1948. Brief checks on released birds have indicated very poor survival, particularly in spring-released birds

ment in Missouri indicates that native bobwhite will build up higher populations on a given area when food and cover are increased. It must also be kept in mind that soil fertility and climate set a top limit on the bobwhite population density for a given area. One cannot expect to establish a population of one bird per acre on land that is capable of supporting at its best only one bird per 10 acres. Errington (1936) has emphasized that environmental improvement, rather than restocking, is the best remedy for a quail shortage. Winter carrying capacity regulates the populations of bobwhite in the northern part of their range (probably the southern range as well) and only a certain number of birds survive in a given territory "regardless of how open the winters may be and regardless of the kinds and numbers of enemies present."

Buss, Mattison, and Kozlik (1947) have shown that on a natural, unshot bobwhite quail range in Wisconsin the normal annual turnover was 83 per cent, and that most of the mortality occurred to adults during the spring season. This indicates that pen-reared birds should be harvested heavily in the fall, that few will survive the winter, and that only an insignificant number may produce young.

When bobwhite populations are low following severe winters or poor nesting seasons, more pen-reared birds survive than during normal seasons. Baumgartner (1944) found that after the wild population had been depleted through severe winter losses fair survival of hatchery birds occurred. Similar evidence of fair survival after depletion of native stock is indicated in the comparatively high recovery (12.5 per cent) of bands from Okfuskee County, Okla-

homa (Anonymous 1948a). During the 1947 nesting season, torrential rains greatly reduced the nesting success; the rainy season was followed by prolonged hot dry weather for the remaining part of the summer. Apparently these conditions were advantageous to the survival of pen-reared birds since competition from native birds was reduced.

REESTABLISHMENT OF NATIVE STOCK

Nestler and Studholme (1915) state that natural recovery of badly decimated native populations is a rather slow process and that new stock must be introduced if rapid growth of population is desired. No factual basis is given to support this contention. Hanson (1947) presents information to the contrary in his statement that severe winters like that of 1929-1930 may seriously reduce the numbers of bobwhite, but in a season or two they may be back to normal. The hunting season of 1932 is still remembered as a banner year. A population increase from one bird per 6 acres to one bird per 3 acres over a three-year period is reported by Sanders (1913). Another rapid recovery of bobwhite is shown by Errington (1915) in his fifteen-year local study of the northern bobwhite. The population was low from 1936 to 1938, but in 1939 the fall population was more than double that in the fall of 1938. In Oklahoma (Duck and Fletcher 1944) a considerable decline in bobwhite populations occurred after the severe winter of 1939-1940, yet by the fall of 1941 populations were back to normal. Duck and Fletcher do not believe that hatchery birds contribute to recovery of low native populations. Recoveries

from low population levels in northwestern Oklahoma in 1941 were equally rapid on restocked and non-restocked areas. In southwestern Texas phenomenally rapid recovery of bobwhite has been observed. Lehmann (1946) states that a pasture supporting one bird per 2 or 3 acres in the spring may have a low population the following autumn, and conversely, a ranch where quail are scarce one year often supports many the following season. In good habitats throughout most of Texas, only one good breeding season is necessary to fill the coverts to capacity from the natural increase of quail already present.

Undoubtedly the contradictory viewpoints about the rapidity of recovery in native bobwhite arise in part from conflicting evidence from the favorable southern ranges and marginal northern ranges.

ECONOMICS

Hart and Mitchell (1941) report that each hatchery bird costs only \$0.77 at the time of liberation. Their band returns (25 per cent, 1930; 18 per cent, 1940), however, show that each bird bagged was worth \$3.00 to \$4.00. Clark (1942) reports that the average cost per hatchery quail in 1911 was \$0.86 in the United States. Brill (1941b) gives an account of experience in Oklahoma in the improvement of egg production and adult quality, while at the same time the cost of production was reduced to \$0.70 per bird. But at an average of 1.26 per cent in band returns over a five-year period (Hanson 1947), the cost per bird brought to bag is \$55.56. The report from Okfuskee County (Anonymous 1948a) indicates

that the 12.5 per cent band returns represent well over half of the bands taken by hunters. Assuming that the actual number of banded birds killed was 25 per cent of those released and that each bird was valued at \$0.70 when liberated, the cost per bagged bird would be \$2.80.

The success of restocking must be measured by survival to the breeding season and hunter success in the fall. The above data summarized from several states show that few birds provide breeding stock whether released in the spring or fall and that few are taken by hunters. While it may be economical to raise bobwhite, it has not been demonstrated that restocking from state game farms can be maintained on a financially sound basis. The income from license sales to quail hunters falls far short of the funds required for large-scale restocking.

FUTURE OF RESTOCKING

Gabrielson (Hart and Mitchell 1947) has pointed out that endeavors by state game departments to propagate game in great quantities for sportsmen to shoot result in bankruptcy of game funds. Losses of pen-reared birds upon release are great and the cost of raising the game is far beyond the revenue obtainable from the sportsmen. However, since the cost of producing the birds is largely a labor cost, individuals or groups of individuals who wish to perform the labor themselves or pay the cost of production can augment the supply of game available on their lands.

The Wildlife Society (Anonymous 1948b) has recently summarized the nation-wide experience of game technicians to the effect that no permanent

increase in game resources can be brought about by artificial propagation of birds and mammals. Money spent for artificial propagation often is diverted from useful enterprises, such as habitat improvement.

Steen (1948) makes a plea for facing the fact that the usefulness of artificial restocking as a tool in the public management of game is limited and rare; he points out that precious time and ground are lost in applying wrong remedies and that environmental improvement must be employed to meet the problems of today and build for the future.

While the future of restocking with pen-reared upland game birds cannot be fully predicted, definite trends are shown by Nestler (1947) in his historical compilation of game-bird propagation. Nestler states, "Undoubtedly pressure in favor of propagation of game birds for liberation will continue despite unfavorable evidence of high cost, tameness, and low survival of stock, in order to supply targets for gunners if for no better reason. However, the game-farm epoch in wildlife management, at least so far as public funds are concerned, is probably past its peak, and more attention in the future will be paid to the restoration and improvement of habitat." A further suggestion is made that the propagation of game birds in the future may be to supply the meat market rather than the open fields.

At the present time propagation for restocking purposes seems to be facing a decline, more emphasis being placed on environmental improvement as a means of increasing bobwhite populations.

SUMMARY

The present paper gives special attention to the place in bobwhite management of the method of propagation and release of pen-reared birds. A survey of the literature and policies of 17 bobwhite-quail states, summarized in Table 1, showed that the method is costly and does not materially increase the shootable population of bobwhite. With three exceptions bobwhite game farms in these states are being maintained at low level, production decreased, or abandoned.

Seemingly propagation and release of game-farm birds has a place (1) on suitable areas where the bobwhites have been killed out either by overshooting or some natural catastrophe, or (2) where favorable habitat has been created and is not being stocked by native population. Such instances will be few.

Bobwhite numbers on an area are regulated not by the birds that may be liberated but by the carrying capacity of the area during the season of greatest stress. If the habitat is improved for quail, there will be more birds. If the carrying capacity is not increased, liberation of additional birds may exercise no appreciable effect. The ability of decimated bobwhite populations to bounce back to normal in a season or two from natural increase, at least in Texas and Oklahoma, is clear.

According to our reports costs of hatchery production vary from \$0.08 to \$3.00. Low survival of pen-reared birds results in costs per bird in the hunter's bag from \$2.80 to even \$55.56 in particular cases. Apparently the income from license sales to quail hunters falls far short of the funds re-

quired for large-scale restocking.

In states already possessing large investments in quail farms, the release of pen-reared stock perhaps may be justified as a means of interesting youth groups and sportsmen's clubs.

Such farms might well be used also as production centers for game where clearly justified, on a regional basis, through sale or exchange of pen-reared stock to nearby states. The game-farm birds produced might serve also as research material, perhaps in cooperation with cooperative units or educational institutions or the United States Fish and Wildlife Service for getting answers to some of the questions sure to arise in bobwhite quail food habits, nutrition, life habits, parasites and diseases, adaptation and survival, and population dynamics.

The available evidence clearly indicates little success with large-scale restocking programs. Gabrielson (1946) points out that restocking in any form should be done only in emergencies or when high cost is not an item of consideration. He states that the birds should be released immediately before the hunting season to provide a maximum of return. At the present time, propagated birds are costly. Natural production of game is likely to be far less costly and more practical.

LITERATURE CITED

- Anonymous. 1941. Statewide bobwhite quail management and restocking project, No. 4-D. Pittman-Robertson Report, Oklahoma Game and Fish Commission. 10 pp.
- . 1942. The propriety of attempting to restore bobwhite quail in Texas by raising the quail in pens for release in the wild. Texas Game, Fish and Oyster Commission. Mimeographed. 14 pp.
- . 1943. Why Texas doesn't pen-raise quail. Texas Game and Fish, 3: 6, 10.
- . 1946. Why not pen-raised quail for restocking? Mississippi Game and Fish, 10: 3.
- . 1947. The Missouri conservation program approval and disapproval. Conservation Federation of Missouri. Webster Groves, Missouri. 30 pp.
- . 1948a. Olafsen County Sportsmen's Club proves best cooperator in quail leg-band recoveries. Oklahoma Game and Fish News, 4: 9.
- . 1948b. Report of the joint committee on wildlife. The Wildlife Society and the Division of Biology and Agriculture, National Research Council. The Wildlife Society Newsletter, Winter Issue, 1948.
- BARNER, WILLIAM B. 1947. Is artificial propagation the answer? Outdoor Indiana, 14: 8-10.
- BAUMGARTNER, F. M. and H. S. STONAKER. 1941. An evaluation of the artificial propagation of bobwhite quail at the Lake Carl Blackwell Game Farm. Manuscript. 9 pp.
- BAUMGARTNER, F. M. 1944. Dispersal and survival of game farm bobwhite quail in northcentral Oklahoma. Jour. Wildl. Mgt., 8: 112-118.
- BENNETT, RUDOLF. 1946. Report on a three year quail stocking experiment. Missouri Conservationist, 7: 10-11.
- BILL, CHARLES J. 1941a. Pen-raised versus wild-reared. Southern Sportsman, pp. 24-25.
- . 1941b. Down comes the cost of quail production. Southern Sportsman, 5: 9, 10.
- BURN, IRVEN, HELMER MATTISON, and FRANK M. KOZLIK. 1947. The bobwhite quail in Dunn County, Wisconsin. Wis. Conservation Bulletin, 12(7): 6-13.
- CAMPBELL, JOHN S., GEORGE H. PENN, JR., H. EUGENE WALLACE, and M. GEORGE GRIZO, JR. 1943. Analyses of reported returns from artificially raised bobwhites in 1941. Louisiana Acad. Sci., 7: 34-43.
- CLARK, ARTHUR L. 1942. Annual restocking—game management or public relations? Trans. N. Amer. Wildlife Conf., 7: 179-184.
- DICK, L. G. and JACK B. FLETCHER. 1944. A survey of the game and fur-bearing animals of Oklahoma. Oklahoma Game and Fish Commission. Pittman-Robertson Series No. 11, State Bul. 3, 144 pp.
- ENNINGTON, PAUL L. 1936. Restocking quail in our northern States. Minnesota Conservationist Sept.-Oct., pp. 1-11, 15.
- . 1945. Some contributions of a fifteen-year local study of the northern bobwhite to a knowledge of population phenomena. Ecol. Mono., 15: 1-34.
- FRYE, O. EARLE, JR. 1942. The comparative survival of wild and pen-reared bobwhite in the field. Trans. N. Amer. Wildlife Conf., 7: 168-175.
- GABRIELSON, IRA N. 1946. Changing concepts of wildlife management. Missouri Conservationist, 7: 3-5, 12.
- GERATZELL, RICHARD. 1937. Practical management of the bobwhite quail on the northern range. Penn. Game News, 8: 10-11, 28-29.
- . 1938. An analysis of the reported returns obtained from the release of 30,000 artificially propagated ring-neck pheasants and bobwhite quail. Trans. N. Amer. Wildlife Conf., 3: 724-729.
- HANDLEY, CHARLES O. 1935. The survival of liberated bobwhite quail. Trans. Amer. Game Conf., 21: 377-380.
- HANSON, H. GORDON. 1947. Missing—56,340 bobwhites! Oklahoma Game and Fish News, 3: 20.
- HART, DENNIS and TED MITCHELL. 1941. Report of data and indications as of spring 1941 relative to the value of artificial stocking. Game Restoration Dept., Western Cartridge Co., East Alton, Ill. 12 pp.
- LEHMANN, VALERIE W. 1946. Bobwhite quail reproduction in southwestern Texas. Jour. Wildl. Mgt., 10: 111-123.
- . 1948. Restocking on King Ranch. Trans. N. Amer. Wildlife Conf., 13: 236-239.
- LINON, J. STOKLEY. 1918. Unit administration for upland game birds. Oklahoma Game and Fish News, 4: 6-7.
- MURRAY, ROBERT W. 1948. Wintering bobwhite in Boone County, Missouri. Jour. Wildl. Mgt., 12: 37-45.
- NESTLER, RALPH B. and ALLAN T. STUDHOLME. 1945. The future of pen-reared quail in post-war restocking programs. Penn. Game News, 16: 3, 26-27, 30.
- NESTLER, RALPH B. and JOHN R. LANGENBACH. 1946. Propagated quail versus wild quail as studied under laboratory conditions. Penn. Game News, 16: 6-7, 22-23.
- NESTLER, RALPH B. 1947. Game bird propagation—its beginning, growth, and future. Penn. Game News, 18: 10-11, 30-33, 36, 40.
- PHILIPS, CHESTER F. 1948. Some results of quail restocking experiments in Virginia and neighboring States. Virginia Wildlife, 9: 4 pp.
- POUGH, RICHARD H. 1918. The arguments against the annual stocking of already inhabited coverts with artificially reared game birds. Trans. N. Amer. Wildlife Conf., 13: 228-235.
- REEVES, M. C. 1948. Tractor vs. quail. Outdoor Indiana, 15: 14-15.
- SANDERS, EARL. 1943. Development of a bobwhite management area in southern Iowa. Iowa Agric. Expt. Sta. Res. Bul., 317: 699-726.
- STEEN, MELVIN O. 1918. Shall we improve habitat or stock—for wildlife? Outdoor America, 13: 4, 10.
- STODDARD, HERBERT L. 1931. The bobwhite quail: its habits, preservation and increase. Charles Scribner's Sons. 550 pp.
- . 1936. Bobwhite quail and their preferred cover. Outdoor Florida, 1: 11-12.
- STUDHOLME, ALLAN T. 1948. A bird in the bush is worth two in the hand. Trans. N. Amer. Wildlife Conf., 13: 207-214.
- TAYLOR, WALTER P. 1948. Land wildlife resources of the south. Manuscript, 102 pp.

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